Energy Savings Assessment (ESA) Summary Report
For 3M – Brownwood, TX Plant (Nov. 7-9, 2005)

Public Summary Report for the Energy Savings Assessment:

Introduction: An Energy Savings Assessment (ESA) was carried out at 3M Company's Brownwood, TX plant that manufactures several products related to traffic safety. The assessment was supported by the plant engineer Vaughn Costa and the 3M corporate energy manager Steve Schultz. Representatives from four other 3M plants (Austin, TX, Guin, AL, Nevada, MO and Decatur, AL) attended this assessment. The assessment was led by the DOE process heating specialists Arvind Thekdi and Richard Bennett. Prior to the assessment the DOE experts (assessors), Vaughn Costa and Steve Schultz had discussed details of the assessment process, reviewed available data on energy use in the plant heating equipment and agreed that the attendees would down load Process Heating Assessment and Survey Tool (PHAST) program on their laptop computers for its use during the assessment.

Objective of the Assessment: Main objective of the assessment is to provide hands-on training and demonstration of the data collection process, and use of PHAST to identify energy saving opportunities for selected heating systems in the plant.

Focus of assessment: The assessment was focused on process heating systems that use natural gas and/or energy derived from natural gas fired systems. The 3M Brownwood, TX plant has over 30 direct fired heating systems that use natural gas. This equipment can be divided into 6 major categories: small furnaces (10), boilers (2), ovens (6), large furnaces (2), TCP unit and others that include a thermal oxidizer, several dryers, etc. Additionally the plant has more than 100 make-up air units that are heated by steam produced in natural gas fired boilers.

Energy (natural gas) use for the equipment is distributed as shown in Figure 1 below.

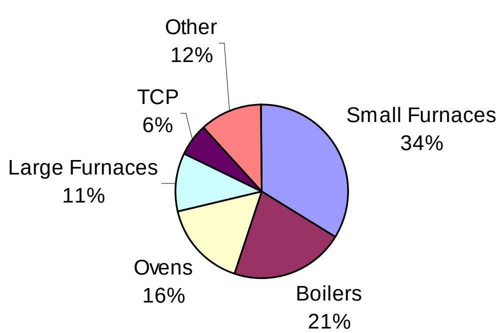

Figure 1. Energy use distribution for direct fired heating systems at the plant

Out of this list the group selected four representative heating systems: large furnace A, one small furnace, oven #32 and boiler #2 for the energy assessment.

Approach for ESA: The assessment activities included (a) review of energy use by the plant, (b) plant tour, (c) brief introduction and fundamentals of combustion, heat transfer and heat recovery systems related to process heating equipment, (d) demonstration of PHAST and instructions on its use, (e) collection of the required data for PHAST, and (f) analysis of energy saving opportunities for the four systems mentioned above. Measurements were carried out by three teams of personnel selected from the attendees. The teams were given hands-on training for data collection, use of the data for PHAST and use of PHAST for energy saving analysis. Several additional issues related to operation, maintenance and use of new technologies were discussed. The plant management was briefed on the assessment results on the third day of the assessment.

General observations. The assessment process included measurement of key parameters required to collect data required for PHAST. The team members received hands-on experience in use of available instruments to collect necessary data. Most of the data was collected relatively easily. However it was difficult to get flue gas temperature from the furnaces due to high temperature and difficulty in accessibility. It was also observed that data collection for O2 reading in oven exhaust gases and boilers is difficult due difficulty in accessibility. The plant personnel provided exceptionally good cooperation in providing access ports etc. It was also realized that PHAST program itself needs updating to allow calculations of available heat for exhaust gases with very high oxygen content and also for wall heat loss calculations at lower surface temperatures as encountered in low temperature ovens. These limitations were corrected by using other source of information provided by the DOE experts or assessors. Important lessons learned are: discuss requirements for access ports and, if possible, get them ready before the assessments; calibrate and test instruments (particularly the O2/combustible meter) prior to the assessment; observe areas of opportunities that are indirectly connected to process heating systems such as HVAC systems that use energy that can be substituted by use of waste heat from process heating equipment.

Potential opportunities: The plant has an active energy team and they have done a very good job of implementing commonly known ("low hanging fruits") energy saving opportunities. For this report natural gas cost is accounted at $8.80 per million (MM) Btu and electricity cost at 10 Cents per kWh. Major energy saving opportunities are in the areas of waste heat reduction and recovery in heating systems, control of burner operations, operating practices (i.e. operations at design capacity to maintain high efficiency levels), and use of waste heat to replace steam from natural gas fired boilers. Near term (<1 year payback) opportunities identified during this assessment may save 1.5% to 2% and the medium term (< 3 years payback) opportunities may save >5% natural gas cost. The long term (> 3 years) opportunities related to process changes etc. can result in substantially more savings (not estimated at this time). Detail files for PHAST analysis have been transmitted to the attendees for their use. A list of opportunities, divided into three categories (Near term, medium time frame and long term) is given in Figure 2. This figure includes definition of near term etc.

Management support and comments: The plant management was highly supportive of implementing the near and medium term opportunities with due considerations for the long term opportunities. They also advised the plant personnel to purchase necessary instrumentation for continuing monitoring and assessment of process heating systems.

Need for DOE to contact plant/company: DOE may contact Steve Schultz at 3M corporate and Vaughn Costa at the plant to monitor progress made towards implementation of the recommendations.

Report prepared by

Arvind Thekdi, E3M, Inc.

Richard Bennett, Janus Technologies Group.

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Figure 2: List of recommendations

Near Term*

- Tune the large furnace burners to get proper air-fuel ratio – 2% or less O2 in flue gases. Potential savings - $80,500 per year.
- Install proper controls (temperature control or other type close loop control – feed rate control) for the large furnaces. Benefits would be improved production and better quality control.
- Adjust boiler burners to maintain approximately 2 % O2 in exhaust gases regularly at average operating conditions. Expected savings $8,380 (conservative with possibilities of higher savings depending on steam production and average current value of O2 in flue gases) per year depending on current operation, adjustments etc. This can be done by using manual adjustment or tuning the burners periodically (i.e. twice a year) and by operating the boilers at as close to full load as possible to maintain efficiency of the boilers. The estimate is based on $8.50/MM Btu, 6000 hrs. /year, one boiler @15,000 #s/hr. average steam production and reduction of flue gas O2 from 3% to 2%.
- Purchase basic instrumentation such as an oxygen/combustible analyzer to allow frequent measurement of flue gas analysis for the heating systems.

Medium Time Frame*

- Install O2/CO trim control for boiler
- Install a stack recuperator to heat air (or water) and recover heat from furnace exhaust gases. Use air for dryer and water for make-up air heating. Savings are $107,000 per year
- Install an economizer or hot water/air heater for boilers to recover heat from the boiler flue gases
- Water heating by using thermal oxidizer exhaust gas heat (available at approximately 350 deg. F. and 125,000 scfm flow rate) and use water for make-up air heating and/or humidification of air in winter months. Dropping 100 deg. F. temperature can save approx. $135 per hour or at 6000 hours per year operations, total of $810,000. The savings could be higher ($1.08 million per year) if operating hours for the thermal oxidizer and the "host" heating would increase to 8,000 hours/year. For this report we would use $800,000 as target savings. It should be noted that it is necessary to find use of this heat in the plant. Possible options are to replace steam from make-up air heaters, use of water spray for humidity control, use of water heat for absorption (adsorption) chiller system etc.
- Use of exhaust gas heat (if clean) from the small furnaces to preheat air or water.
- Improve insulation for the large furnaces during the next rebuild

Long Term*

1. Consider use of hot water to supply heat to a thermally activated absorption cooling system. This would eliminate use of electricity for chillers.
2. Use desiccant dryer to dehumidify make-up air and eliminate use of chilled water to reduce humidity in air prior to reheating. This will also reduce steam requirement for reheating the air.
3. Preheat feed material for the furnaces by using hot air from the recuperator (use furnace exhaust gas heat to heat the air)
4. Consider use of oxy-fuel burners for the large furnaces
5. Consider use of carbon bed system to concentrate vapors in press exhaust air

Notes:

1. Definitions of the terms.
   - The near term opportunities include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
   - The medium term opportunities would require purchase of additional equipment and/or changes in the system such as addition of recuperative air preheaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
   - The long term opportunities would require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

2. The boiler fuel use is based on production of approximately 15,000 #s/hour steam using one boiler at near full-load condition. The boiler firing rate is based on production of saturated steam at 140 psig.